

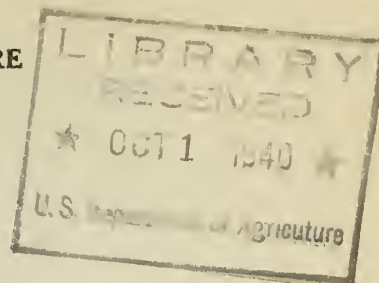
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UNITED STATES DEPARTMENT OF AGRICULTURE
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and
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in cooperation with
THE CLEMSON AGRICULTURAL COLLEGE



SPINNING AND FIBER PROPERTIES OF PIMA, SxP AND A PIMA-SxP BACKCROSS

By

Malcolm E. Campbell and Enoch Karrer, Senior Cotton
Technologists, and John M. Cook, Associate Cotton Technologist,
Agricultural Marketing Service

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INTRODUCTION

Previous spinning tests, made both by commercial mills and in the laboratories of the Department, have shown that although Pima cotton is usually longer in staple than SxP, the latter practically always produces yarns that are both stronger and of better appearance. ^{1/} The generally recognized superior quality of the SxP variety is being reflected in the demand for this cotton, and consequently in the proportion which SxP constitutes of the total crop of American-Egyptian cotton. There is still some demand, however, for Pima, partly because of its somewhat longer staple.

In recent years, the Department has made an effort to produce a cotton having the length of Pima but the other desirable fiber properties of SxP. As a result there has been developed a new variety with a number

^{1/} Kearney, T. H., Peebles, R. H. and Smith, E. Gordon, "SxP Cotton in Comparison with Pima." U. S. Dept. Agr. Circular No. 550. Apr. 1940. 15 pp. illus.

of desirable production characteristics, but about the quality characteristics of which little or nothing is known. The tests here described were conducted, therefore, to obtain as much information as possible on the spinning quality and fiber properties of this newly developed variety. To permit comparisons of the new variety with Pima and SxP, samples of these cottons were included in the tests.

HISTORY AND AGRONOMIC CHARACTERISTICS OF THE BACKCROSS (P X SxP) 2/

The SxP variety was developed from a cross between the Egyptian Sakel (Sakellaridis) variety and the Pima variety. It has been found to be more productive than Pima and to possess larger bolls, smoother seeds, and a higher lint percentage. As previously stated, its spinning quality is generally superior to that of Pima.

In the hope of obtaining a variety having the desirable character of SxP but a somewhat longer staple, plants of the ninth inbred generation of SxP were backcrossed on Pima. After a few generations, a variety, hereafter referred to in this report as the Backcross variety, was developed from one of these crosses that proved to be as fixed and uniform as are SxP and Pima. From the grower's point of view, this variety has many desirable qualities. The plants are usually smaller and they mature somewhat earlier than the two older varieties. The bolls are as large, the lint percentage as high, and the seeds as nearly devoid of fuzz as in SxP. In fact, ginners find that the Backcross cotton apparently gins somewhat faster than SxP. Preliminary determinations of lint length by the sorter method indicated that the Backcross variety was nearly intermediate between Pima and SxP, both in absolute length and in uniformity of length. In these determinations of length SxP had the shortest but the most nearly uniform lint of the three varieties.

In numerous yield tests, during the years 1936 to 1939, the performance of the Backcross has been very satisfactory. All 3 varieties were compared in 14 tests, with the result that the Backcross ranked first in yield of seed cotton in 9 tests, second in 2 tests (in which SxP ranked first), tied with SxP for first place in one test, and ranked third in only two tests. Because of its higher lint percentage, it doubtless slightly surpassed Pima in yield of lint in these instances, also. After computing the yields in terms of seed cotton per acre, and averaging the results of the 14 tests, it was found that the average yield of the Backcross was 4 percent higher than that of SxP and 13 percent higher than that of Pima.

The Backcross variety, considered solely from the standpoint of field performance, would seem to be somewhat the best of these three

2/ This section of the report was prepared by T. H. Kearney and R. H. Peebles, Bureau of Plant Industry, U. S. Dept. Agr.

varieties of American-Egyptian cotton, although not greatly superior to SxP. Spinning performance is, however, one of the most important tests of a new variety. Regardless of the performance of a variety from the standpoint of yield, earliness, type of plant, or other factors, it is questionable whether a variety can be marketed profitably in competition with another that is superior from the manufacturer's point of view.

THE COTTONS

Seven samples of cotton were included in these tests, as follows: Pima, SxP, and Backcross grown at Corcoran, Calif., in 1937; and SxP and Backcross grown at Shafter, Calif., and at State College, N. Mex., in 1939. The samples from the 1937 crop were ginned at the U. S. Field Station, Shafter, Calif., and those from the 1939 crop, at Washington, D. C. After ginning, the samples were placed in loosely packed bales and shipped to the spinning laboratory at Clemson, S. C.

TEST PROCEDURE

As soon as the test bales were opened for the tests, samples were taken from the top, middle, and bottom of each lot for classification. These samples were classed by the Appeal Board of Review Examiners, in Washington, D. C.

These samples also served as the bulk laboratory samples for the fiber tests in the laboratories of the Agricultural Marketing Service in Washington. Tests were made of fiber length and length distribution; of strength, by the Chandler bundle method; of fineness, both by determination of weight per inch and by cross sectioning; and of immaturity, or percentage of thin-walled fibers.

Each spinning test sample was spun into combed 80s, 100s, and 120s warp yarns, in accordance with the usual organization and procedure employed for long-stapled cottons at the spinning laboratory. Waste determinations were made at the pickers, card, and comber, by collecting and weighing all of the waste removed by each cleaning machine. The twist multiplier used for spinning was the optimum multiplier determined by making skein tests of yarn that was produced in preliminary spinnings with several different degrees of yarn twist. During manufacturing, observations were made as to the general "spinning performance" of each of the cottons in the test. Each of the yarns spun was subjected to skein-strength and size tests. Samples of the 80s and 120s yarn from each lot were wound on black boards and graded for appearance.

RESULTS

Classification.- In table 1 are listed the results of the classification of the test samples. Each item listed is the average for the three samples drawn from each lot of cotton.

Table 1. - Grade, staple length, and character of cottons tested 1/

Crop year, place grown, and variety	Grade number	Staple length (inches)	Uniformity of length 2/	Strength 3/	Body	Composite character
Crop of 1937:						
Corcoran, Calif.:						
Pima	2	1-3/4	Regular	Strong	Medium	Normal
S x P	2 to 3-1/2	1-1/2 to 1-9/16	Irregular	Fair	Light	Soft
Backcross	3	1-1/2	Very slightly irregular	Fair	Light	Soft
Crop of 1939:						
Shafter, Calif.:						
S x P	1	1-5/8+	Regular	Strong+	Medium	Normal+
Backcross	4/ 1-	1-9/16	Regular	Strong	Medium	Normal+
State College, N. Mex.:						
S x P	2-1/2	1-9/16-	Irregular	Normal	Medium	Normal
Backcross	2-1/2	1-1/2 to 1-11/16	Irregular	Weak	Light	Weak

1/ Each observation is the average of three samples taken at the spinning laboratory of the Agricultural Marketing Service and classed by the Appeal Board of Review Examiners.

2/ Regular indicates average uniformity. Irregular indicates slightly below the average.

3/ Strong indicates unusual strength. Normal indicates average or good strength. Fair indicates slightly below normal but acceptable. Weak indicates poor strength.

4/ Grade reduced on account of preparation.

Of the Corcoran samples, the Pima impressed the classers as longer-fibered, slightly higher in grade, and of considerably better character. There was little to choose between the SxP and the Backcross, except that both the grade and the staple length of the SxP appeared to be slightly more variable.

The Shafter cottons were in general of high quality, according to the classers, who found them to be of much better grade and character than the corresponding varieties from the other two locations. When the plus and minus signs are considered, it is seen that the SxP was thought to be slightly the better of the two Shafter cottons. It was also longer in staple length. The chief difference between the two State College samples was in the strength and body of the fibers, as appraised by the classers, who found the SxP to be superior to the Backcross in these respects. In classing the two State College cottons, the classers observed that both of them were "soft and spongy."

Fiber properties.-In table 2 are listed the data relating to fiber length, fineness, immaturity, and strength for each of the 7 cottons tested.

Table 2. Fiber properties of cottons tested

Crop year, place grown, and variety	Length			Weight per inch	Thin- walled fibers	Chandler bundle strength
	25 per- cent point	Mean	Coeff. of varia- bility			
	<u>Inches</u>	<u>Inches</u>	<u>Percent</u>	<u>ug./in.</u>	<u>Percent</u>	<u>1000 lbs./ sq. in.</u>
Crop of 1937: Corcoran, Calif.:						
Pima	1.627	1.331	31.1	2.9	24.1	87.7
SxP	1.571	1.309	28.7	2.7	25.6	87.5
Backcross	1.566	1.281	30.5	2.7	25.7	86.3
Crop of 1939: Shafter, Calif.:						
SxP	1.602	1.398	23.2	2.9	17.1	86.6
Backcross	1.592	1.307	31.1	3.1	15.5	84.2
State College, N. Mex.:						
SxP	1.589	1.353	26.2	3.2	11.6	79.2
Backcross	1.584	1.258	34.2	2.9	19.4	81.1

The relative lengths of the cottons as determined by the sorter differ somewhat from the classers' appraisals of them, although the rank for a given location is about the same for both types of measurements. It is probable that the difference is due in part to a difference in the length variability of the cottons.

At the 25-percent point in the array the lengths for the SxP and the Backcross are practically the same for a given location, but the coefficients of variation for the SxP are noticeably less and the mean lengths are greater. From this it would appear that, contrary to the hope of the breeders, the Backcross failed to produce a length greater than that of the SxP. Both of these varieties from Corcoran are shorter at the 25-percent point and also in mean length than the Pima by slightly less than 1/16 inch. The classers noted a difference of 3/16 to 1/4 inch.

In weight per inch there is no significant difference among the varieties for each location. The Corcoran samples are slightly finer, on an average, than those from Shafter and State College. Reference to the data for percentage of thin-walled fibers shows that the Corcoran samples are somewhat less mature, and this probably explains why they are finer.

Photomicrographs of the fibers of each sample in cross section revealed no significant difference in fineness or maturity. Fiber strengths likewise differed only very slightly for the cottons produced at a given location. The samples grown at Corcoran and Shafter are somewhat stronger than those grown at State College. The latter samples are somewhat weaker than the average American-Egyptian cotton tested in the laboratories.

Manufacturing waste.-Data pertaining to the quantities of waste removed by the pickers, card, and comber from each of the cottons tested are shown in table 3.

The relationships between the SxP and the Backcross from the three locations were consistent with respect to the total quantity of manufacturing waste removed, in that from 1.76 to 2.15 percent more waste was taken from the Backcross samples. It may be seen that these differences are due almost entirely to the greater proportion of comber waste removed from the Backcross. This is probably a reflection of the greater variability of fiber length in the Backcross, as brought out in table 2. The data for picker and card waste are not greatly different in the case of each pair. For the Corcoran samples, the Pima and the Backcross were about the same in total waste, but differed somewhat as to the components. The Shafter cottons, which were highest in grade, gave up less waste than the others, mainly because of the smaller proportions of comber waste extracted from them.

Table 3. - Grade and manufacturing waste for cottons tested

Item	Waste percentage ^{1/}						
	Corcoran, Calif.			Shafter, Calif.		State College, N. Mex.	
	1937			1939		1939	
	Pima	S x P	Back-cross	S x P	Back-cross	S x P	Back-cross
	2	2 to 3-1/2	3	1	1-	2-1/2	2-1/2
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Kind of waste:							
Picker waste							
Vertical opener	1.04	0.84	0.86	0.34	0.34	0.87	0.70
Breaker	.81	.68	.67	.50	.37	.50	.37
Finisher	<u>.47</u>	<u>.40</u>	<u>.38</u>	<u>.21</u>	<u>.23</u>	<u>.28</u>	<u>.25</u>
Total, pickers	2.30	1.90	1.89	1.05	.94	1.63	1.31
Card waste							
Flat strips	4.78	4.89	4.66	5.31	5.31	4.82	4.98
Cyl. & doff. strips	1.18	1.18	1.12	1.34	1.30	1.26	1.17
Motes and fly	1.36	1.18	1.21	.63	.67	.84	1.10
Sweepings	<u>.18</u>	<u>.16</u>	<u>.22</u>	<u>.09</u>	<u>.13</u>	<u>.07</u>	<u>.15</u>
Total visible	7.50	7.41	7.21	7.37	7.41	6.99	7.40
Picker and card waste							
Total visible	9.58	9.10	8.92	8.30	8.25	8.43	8.50
Total invisible	.31	.71	.55	<u>2/.11</u>	<u>2/.42</u>	.37	1.00
Comber waste	12.50	10.81	13.14	9.67	11.60	12.08	14.47
Picker, card, and comber waste							
Total visible	20.84	18.79	20.82	17.18	18.94	19.45	21.60
Total invisible	.72	.44	.83	<u>2/.32</u>	<u>2/1.09</u>	<u>2/.14</u>	1.11

^{1/} The waste percentage for each cleaning machine is based on the net weight of cotton fed to that machine. The totals, except for card, are based on the weight of cotton fed to the vertical opener.

^{2/} Invisible gain.

It should be pointed out that the percentage of comber waste that is to be removed from a cotton depends not only upon the physical properties of the cotton, but also upon a number of adjustments or settings of the cleaning machine--pickers, card, and comber. It is the usual practice to take out as much waste as is necessary to produce a product of the desired quality, although economical considerations also must be taken into account. This is particularly true of the comber, where waste percentages are usually much higher, and where a much wider range of percentages is obtainable. In tests of this sort, it is obviously impractical to attempt to produce the same quality, with respect to cleanliness and appearance of the product, from each of the test cottons. Therefore each sample is treated in the same manner, and the comber waste data are only general indexes of what would have to be done in commercial production. The data should be examined along with measures of the appearance of the yarns to obtain a more complete picture of the waste relationships of the cottons in the test.

Strength of yarn.--In table 4 are shown the average skein strengths for 80s, 100s, and 120s combed warp yarn spun from each of the test cottons. Each mean is the average of 50 skein tests, and the figure given at the right of each mean is the standard error of the mean. This value reflects the dispersion of the corrected skein breaking strengths in each case.

The yarns spun from the SxP were noticeably stronger than those spun from the Backcross grown at the same location. This difference in favor of the SxP yarns over the Backcross averaged 7.9 percent for 80s, 8.5 percent for 100s, and 13.0 percent for 120s, based on the strengths of the yarns spun from the Backcross. Likewise, for the cottons grown at Corcoran, Calif., in 1937, the SxP yarns were from 5.9 to 9.0 percent stronger than the Pima yarns; and the Pima yarns, in turn, were slightly stronger than those spun from the Backcross except in the case of the 100s, where they were of about equal strength.

The differences in yarn strength for SxP and the Backcross are explainable, at least to some extent, by the difference in mean fiber length. (See table 2.) The difference in length does not explain the superiority of the SxP over the Pima grown at Corcoran since Pima is the longer. They do differ slightly, however, in other measured fiber properties in such a manner as to favor the SxP, and possibly they differ in untested character properties.

These differences in favor of the SxP are large enough to be considered a real advantage in manufacturing, particularly when the cotton is to be used for thread or mechanical fabrics. In many respects, yarn strength is the most important single quality index of cotton, and it is evident from the results of these strength tests that the SxP is superior to both the Pima and the Backcross in this regard.

Appearance of yarn. - At the present time the new standards for yarn appearance have not been used a great deal at the spinning laboratories for fine combed yarns, and it is not known definitely what grade could be considered the lowest for all-round acceptability. (Table 5) There is some question as to whether a B+ yarn would be sufficiently even and free of neps to meet all requirements. It is reasonably safe to say, however, that an A- yarn would be quite satisfactory, and that for many purposes, a B yarn would not.

Table 5. - Appearance grade of yarn spun from cottons tested

Sample	Grade of yarn for	
	80s	120s
Crop of 1937:		
Corcoran, Calif.		
Pima	B	C+
S x P	B	B
Backcross	B	B
Crop of 1939:		
Shafter, Calif.		
S x P	A-	A-
Backcross	B	B+
State College, N. Mex.		
S x P	A	B+
Backcross	B	B+

On such a basis, there are only two cottons in this test that could be called very good from the standpoint of yarn appearance. These are both of the SxP strain, produced at Shafter and State College. It is probable that the appearance of the Backcross 120s yarns grown at both of these points would also be acceptable for most use requirements.

It is of interest to note that although more comber waste was extracted from the Backcross grown at Shafter and State College (table 3), with the exception of one yarn in which they were of equal grade, the SxP yarns were of a better appearance than those spun from the Backcross. This would indicate that if it were possible to improve the appearance of the Backcross yarns, this could be done only at a considerable sacrifice of cotton poundage in the form of comber waste. Such a remedy would result, of course, in an increase in manufacturing cost when processing the Backcross cottons.

Manufacturing performance. - Some trouble was encountered in passing each of the test cottons through the comber, drawing frame, and slubber, because of a tendency for the fibers to adhere to the drawing rolls. This is frequently considered to be a characteristic of American-Egyptian cottons. No one cotton was appreciably different from the others in this respect, however, and it is possible that the difficulty was due in part to the new condition of the machinery, which had only recently been used for the first time.

Rates of spinning end breakage are shown in table 6. A rate of more than 4, or at the most, 5, ends down per 100 spindles per hour is considered too high for practical commercial spinning. However, because of the small number of spindles run and the short period of spinning to which these data relate, the degree of precision is not very high.

Table 6. - Rate of end breakage during spinning of test cottons

Sample	Ends down per 100 spindles per hour for		
	80s	100s	120s
Crop of 1937:			
Corcoran, Calif.			
Pima	00	00	6.6
S x P	00	00	00
Backcross	4.8	12.4	13.2
Crop of 1939:			
Shafter, Calif.			
S x P	00	00	9.9
Backcross	00	12.4	13.2
State College, N. Mex.			
S x P	00	00	3.3
Backcross	00	12.4	46.2

The Pima and SxP may be considered satisfactory for 80s and 100s, from the standpoint of spinning end breakage, and in two of the three cases, SxP is suitable for 120s. It is possible that under commercial conditions the Pima and the Shafter SxP cottons would also be spun into 120s without too high a rate of end breakage. The results indicate, however, that all three of the Backcross samples would give trouble in spinning 100s yarn or finer counts.

SUMMARY

A new variety of cotton has been developed by the Bureau of Plant Industry by backcrossing SxP on Pima. It was the purpose of this work to develop a cotton with the longer staple of Pima and the slightly more desirable character of SxP. The tests described in this report were conducted to determine the spinning and fiber properties of the new Backcross variety as compared with those of SxP and Pima.

Seven samples of cotton were tested, as follows: one sample each of Pima, SxP and the Backcross grown at Corcoran, Calif., in 1937; and one sample each of SxP and the Backcross grown at Shafter, Calif. and at State College, N. Mex. in 1939. Each of the cottons was spun into 80s, 100s and 120s combed warp yarns at the spinning laboratory of the Agricultural Marketing Service, Clemson, S. C. Particular attention was given to manufacturing waste, yarn strength and appearance, and manufacturing performance. Fiber tests made in the Washington laboratories included length, Chandler bundle strength, fineness according to both weight and cross-section, and maturity.

The classers considered the Pima cotton to be about 3/16 inch longer and of better character than the SxP and the Backcross grown at Corcoran. They found but little difference between SxP and the Backcross grown at any of the three locations.

Fiber length measurements made in the laboratory showed that there was no significant difference between SxP and the Backcross in the lengths at the 25 percent point of the array, but that in mean length the SxP was appreciably longer. The Pima sample was found to be somewhat longer than the other two varieties. The fiber tests showed that the SxP was more uniform in length, and that the other fiber properties were practically the same for the cottons grown at a given location.

From these tests it may be concluded that, contrary to the hopes of the breeders, the Backcross was possibly a trifle shorter than the SxP, although the other fiber properties were about the same for the two cottons.

Manufacturing waste for the Backcross was from 1.76 to 2.15 pounds per hundred greater than that for the SxP. The difference was due almost entirely to the greater proportion of comber waste yielded by the Backcross, which is probably a reflection of the greater variability of fiber length of this cotton. The Pima and the Backcross grown at Corcoran were about the same in total waste but differed somewhat as to the components.

Yarns spun from the SxP samples averaged from 7.9 to 13.0 percent stronger than the Backcross yarns, depending upon the yarn count. For

the Corcoran samples, the SxP yarns were from 5.9 to 9.0 percent stronger than the Pima yarns which, in turn, were slightly stronger than the Backcross yarns in two of the three counts. The more favorable showing of the SxP yarns with respect to strength would be considered a real advantage to the manufacturer.

Yarn appearance was distinctly in favor of the SxP cotton, which would thus find a considerably wider application than either the Backcross or the Pima.

The frequently encountered tendency for the fibers of American-Egyptian cotton to adhere to the machine drawing rolls was observed in all of the samples tested with no outstanding differences. Spinning end breakage was higher for the Backcross than for SxP and Pima, and indicated that the Backcross might be unsuited for the spinning of 100s or finer yarns.

In general, the results of these tests showed that the SxP samples possessed a marked superiority in manufacturing quality over both the new Backcross variety and the Pima cotton.

